

HS6300-W Course PDF - February 25, 2015

Module 1

1.1 Radiological Worker II Training : Contamination Controls

Notes:

Welcome to HS6300-W, Radiological Worker II Training. Because the course materials are extensive, you may choose to close the course at the end of a module and return to it later. If you use the same computer, the computer will return you to the point where you left off and you can continue with your training.

1.2 Overview

Notes:

You need to have completed two courses prior to taking this course. These course are, HS6010-W “Radiological Worker Training” and HS6010-P “Integrated Radiological Worker Practical.” If you have not completed the first two courses, you cannot receive credit for this course.

When you have completed all three courses, you will have Radiological Worker training that is equivalent to DOE Radiological Worker II.

1.3 Additional Radioactive Material Handling Training

Notes:

Depending on the type of work you need to do, you may need additional radiological training, as shown in this matrix.

If you use anti-contamination clothing, you need to take HS6340, “Anti-Contamination Clothing or Anti-Cs.”

You may also need more specific isotope courses, such as, HS6311-W on use of Tritium, HS6312-W on use of Uranium, HS6313 on use Plutonium or HS6316 on low level laboratory usage of isotopes.

1.4 Radiation Safety : ES&H Vol. II

Notes:

The documents that govern the Lab's radiation safety program are in Volume II of the ES&H Manual.

Document 20.2, "LLNL Radiological Safety Program for Radioactive Materials," contains the requirements and controls for use of radioactive materials including dispersible radioisotopes, including:

Radiological Hazards

Radiation Protection Standards

Radiological Design Criteria

Work Planning

Conducting Routine Radiological Work

Control of Radioactive Material

Responsibilities

Resources for More Information

This course largely covers the information in Document 20.2. This will prepare you to safely handle dispersible radioactive materials after completing the course.

It is important that you read and become familiar with the portions of the ES&H Manual documents that apply to your work. You can click on the link to access the table of contents for Document 20.2.

1.5 Course Goal

Notes:

After completing this course, you will be able to safely conduct your radiological work involving dispersible radioactive materials.

1.6 Next Steps

Notes:

This module was our introduction to HS6300-W.

As we proceed during this course, you may choose to review any topics you feel unsure about at this time by using the menu bar on the left to select a topic.

When you are finished reviewing, select the last topic on the menu, called the Module Summary, and then click on the quiz button.

Except for this introduction, there will be a quiz for each module throughout the course.

You may also wish to refer to the glossary if you have any questions about the terms used in the module. The glossary tab is on the top right of the screen.

When you are ready, click the advance button to move to Module #2.

Module 2

3.1 Radiological Worker II Training : Contamination Controls

3.3 Additional Radioactive Material Handling Training

Notes:

This module begins our discussion of how to safely conduct work with dispersible radioactive materials. This module is specifically about the requirements to start such work. After completing this module, you will be able to safely use dispersible radioactive materials by:

- Working in an appropriate workplace and ensure it is functioning properly
- Observing radiological barriers and postings
- Implementing controls in IWS

Let's start by discussing dispersible radioactive materials and how their hazards differ from non-dispersible materials.

3.4 Radiation Safety : ES&H Vol. II

Notes:

Radioactive materials are either non-dispersible or dispersible. The radiological hazard from non-dispersible material is normally limited to the direct radiation field. On the other hand, dispersible material ALSO allows for the potential spread of activity into unwanted locations. This is the classic definition of radioactive contamination. Controlling such contamination is the primary focus of this course. Remember, dispersible sources always require proper contamination controls. These can include PPE, ventilation controls, secondary containment and physical barriers. We will discuss all of these in greater detail during this course. Let's start by discussing the potential for internal dose related to radioactive contamination.

3.5 Internal Radiation Dose

Notes:

Since dispersible radioactive materials (in the form of radioactive contamination) may come into contact with the human body, we

need to understand how the materials could enter and be deposited in the body, creating an INTERNAL RADIATION DOSE.

There are four ROUTES OF ENTRY :

Inhalation (of gases or dusts into the lungs)

Ingestion (of particulate or liquid contamination through the mouth)

Punctures (or wounds in the skin where materials could enter)

Absorption (through the skin of special physical or chemical forms)

No matter how material enters the body, once it does, it has a natural chemical (not radiological) affinity for one or more organs.

Let's start by discussing the types of contamination and implications for determining an appropriate workplace.

3.6 Types of Contamination

Notes:

Contamination is radioactive materials somewhere we don't want it to be. There are three contamination types ; removable contamination, where activity can be removed (and spread) by

casual contact with the surface and indicated by activity found on swipe surveys . There is also fixed contamination, where direct meter measurements indicate activity on a surface but swipes show the activity is not removable. Fixed contamination may not remain fixed due to changes in temperature or humidity or physical disruption of the surface (through cutting, grinding or welding) which may make contamination removable. Finally, there is airborne contamination, where material has become suspended in breathable air, presenting an inhalation hazard. Read all radiological postings, looking for stated contamination hazards. Obey any controls stated on the postings. If you do not understand information on a posting, contact your ES&H Tech for clarification before entering the area.

3.7 Contamination Sources

Notes:

Sources of radioactive contamination can be both obvious and not-so-obvious. Work activities that involve the destruction of surfaces can easily create and spread contamination. Such activities may include machining, filing, cutting and grinding.

Operations which alter the physical and/or chemical state of materials on the surface of equipment may also create contamination. Such operations may include welding, burning and heating. Sloppy work practices are a likely source of contamination and often lead to cross-contamination of tools, equipment or workers. These include opening radioactive systems without proper controls, poor housekeeping and excessive motion or movement in areas of high contamination. Abnormal conditions can also lead to contamination. These can include breaches of containment, spills and fires.

3.8 Radiological Barriers

Notes:

Radiological barriers are essential in maintaining control over contamination. A barrier is a physical means of containing radioactive material and protecting against internal radiation exposure. . Barriers can include; negative airflow, enclosures (such as a glove box) , HEPA filters , sealed containers (cans, jars, cartons or plastic bags) and process vessels or equipment (e.g., piping or tanks). Barriers must be properly inspected, maintained

and replaced as necessary as they will degrade due to age, wear and radiation degradation.

3.9 Workplace Types

Notes:

Workplaces are categorized as Type 0, I, II, and III, depending on the level of contamination control they provide.

3.10 Workplace : Type 0

Notes:

A Type 0 workplace, for example, a shelf, storage cabinet or drum storage area is used only for the storage of radioactive materials. You must store radioactive materials in a posted or labeled cabinet, drawer, or other designated area when not in use. Use a metal or fire-resistant enclosure whenever possible. All stored radioactive material shall be properly packaged to prevent dispersal. Always limit co-mingling of non-radioactive and radioactive materials in storage areas. If a single cabinet is used for both types of material, you must segregate the radioactive

material on specific shelves. Please remember that a Type 0 workplace provides no specific protection for the worker or the area; it is only suitable for storage of properly packaged radioactive material.

3.11 Workplace : Type I

Notes:

If you are just storing material, a Type 0 is okay, but if you are working with the material you normally need to move up to higher levels of contamination control. A Type I workplace is a laboratory bench top which essentially provides no engineered barrier between you and the radioactive material. This provides minimal protection, but it is suitable for certain kinds of radiological work. Type I workplaces must identify radioactive material work areas with absorbent paper and radioactive material marking tape. Radioactive materials within these areas must be posted with radiation symbols.

3.12 Workplace : Type II

Notes:

A Type II workplace has one barrier between the material and the worker. Because of this barrier, higher levels of dispersible radioactive material and, or more toxic radioactive materials can be handled in a type II workplace than can be safely handled in a type I workplace. Most often, Type II workplaces are negative pressure chemical fume hoods. As in a Type I, you must identify radioactive material work areas with absorbent paper or radioactive material marking tape and post the equipment required to process radioactive materials with radiation symbols. Now let's discuss the Type III workplace.

3.13 Workplace : Type III

Notes:

A Type III workplace has two engineered barriers. Because the type III workplace has two distinct barriers between you and the material, even higher levels of dispersible radioactive material and, or more toxic radioactive materials can be handled in a type III workplace. A type III workplace is usually a HEPA-filtered, negative-pressure glove box within a work area. The physical

boundary of the glove box provides one rigid barrier between you and the radioactive material and in the event that barrier fails (say through a pinhole leak in a glove box glove), the negative air pressure within the box provides a second barrier for your protection. Type III workplaces are required for higher risk activities thus, prior to the initial introduction of radioactive materials into such workplaces, the team health physicist must validate and approve the engineered controls. The glove box must be maintained at negative pressure to the room and the room at negative pressure to other parts of the building. Other protective devices may also be required.

3.14 Module Summary

Notes:

This module discussed these topics. You may choose to review any topics you feel unsure about at this time by using the menu on the left to select a topic. You may also wish to refer to the glossary if you have any questions about the terms used in the module. When you are finished reviewing, click on the quiz button.

You must take and pass the quiz for this module before advancing to the next module.

Module 3

4.1 Radiological Worker II Training : Contamination Controls

Notes:

This module discusses the importance of the LLNL Internal Dosimetry Program and the program requirements.

First let's talk about the importance of the bioassay program.

4.5 Radiation Safety : ES&H Vol. II

Notes:

LLNL maintains an Internal Dosimetry Program to evaluate occupational internal doses received by employees. Workers who are likely to participate in this program include:

Individuals who are expected to receive more than 100 mrem from internal dose,

Individuals assigned to the program based on the discretion of the HP and authorizing organization

Individuals required to participate in the program for cause for example those exposed to a CAM alarm, or containment or system failures.

4.6 Bioassay Program Participation

Notes:

The H&S Tech will provide sampling kits if urinalysis or other in-vitro samples are required. If gamma spectroscopy bioassay analysis is specified by the work control document, , you are required to schedule your visit with the Whole Body Counting Laboratory. It is important that you communicate with your Team HP and the counting lab if for some reason you cannot make a scheduled counting appointment. Individuals should also participate in follow-up monitoring when directed by the Team HP. Finally, if you are enrolled in a bioassay program, please inform your Team HP of any medical treatments involving radionuclides, as these materials may interfere with some techniques or mask the presence of radionuclide(s) of interest.

4.7 Off-normal Events and Bioassays

Notes:

Besides routine operations, bioassays may be driven by off-normal radiological events. These could be : airborne radioactivity incidents, contaminated puncture wounds or burns and spills of radioactive materials. All create the potential for internal contamination, so bioassay is often be used to determine if internal doses have been received.

4.8 Module Summary

Notes:

In this module we have discussed the importance of the LLNL bioassay program.

You may choose to review any topics you feel unsure about at this time by using the menu on the left to select a topic. When you are ready, click the quiz button to take the quiz.

5. Module 4

5.1 Radiological Worker II Training : Contamination Controls

Notes:

In this module, we'll discuss how to work safely in Type I, Type II and III workplaces.

5.9 Additional Radioactive Material Handling Training

Notes:

As mentioned in Module 2, a Type I workplace, such as a laboratory bench top, provides no engineered barrier between the worker and the radioactive material. It does, however, require a laboratory type space that can be controlled and decontaminated, if needed. Type I workplaces must be clearly identified using pre-approved radiological demarcation tape, and the workplace should only be used for radiological work. Depending on the quantity of radioactive material allowed, the

Type I workplace may also require labeling with a trefoil and the words, 'Caution, Radioactive Material'.

5.10 Additional Radioactive Material Handling Training

Notes:

To facilitate contamination control, Type 1 workplaces are typically covered with absorbent paper that, ideally, is maintained below the ES&H Manual Document 20.2 Appendix D contamination thresholds. If the level of contamination on the work surface exceeds any of the Appendix D thresholds, a 'Caution Contamination Area' posting is also required.

5.11 Workplace : Type I

Notes:

If you need to temporarily introduce a clean item, such as a reagent bottle, into an area posted as a 'Contamination Area', you may establish a temporary 'known clean area', introduce and use

the item, and then remove it without a documented ES&H release survey if all the following conditions are met:

The item is protected from cross-contamination and does not come into direct contact with potentially contaminated surfaces.

The item remains under the direct, continuous control of a radiological worker.

The item is monitored prior to removal from the area to confirm absence of contamination.

The establishment of 'known clean areas' within a CA is called out in the work control document.

5.12 Workplace : Type I

Notes:

A secondary containment, such as a photo tray, should be used when handling liquid or easily dispersed radioactive materials, and for segregation of contaminated or potentially contaminated items.

5.13 Workplace : Type I

Notes:

Workers should periodically monitor the work area to verify there has been no inadvertent spread of contamination

5.14 Workplace : Type I

Notes:

If unexpected area contamination is found, stop and call the H&S Tech so a survey can be performed and the proper postings verified.

5.15 Radiation Safety : ES&H Vol. II

Notes:

Type II workplaces provide one barrier between the worker and the radioactive material; typically, that barrier is the negative ventilation associated with a fume hood.

5.16 Radiation Safety : ES&H Vol. II

Notes:

There are many different types of fume hoods in use at LLNL. Older models typically have constant-speed fans, and the proper airflow is obtained by aligning the arrows on the sash and sash frame.

5.17 Radiation Safety : ES&H Vol. II

Notes:

Newer hood models often have variable speed fans that maintain a constant air flow by adjusting the fan speed as the sash is raised or lowered. It is important that you know how your fume hood works, and that you use it as intended by the manufacturer.

5.18 Ensure Proper Hood Function

Notes:

Regardless of what type of hood you're working in, you should ensure it is properly functioning by

Checking the sticker to ensure it has been tested in the past 12 months.

Verifying the ventilation system is 'on' by checking the manahelic guage or other flow indicator.

Aligning the sash with the sash arrows.

5.19 Safe Fume Hood Use

Notes:

The contamination control techniques for Type I workplaces are also applicable to Type II workplaces. In addition, when working in a Type II workplace, you should avoid rapid movements and other actions that might disturb the airflow or create eddy currents.

5.20 Safe Fume Hood Use

Notes:

Specifically, it is important to:

Keep the hood work surface free of clutter. Hoods that are filled with equipment and stored items do not function properly.

Keep the slots at the back of the hood unobstructed so the air flow is unimpeded.

Work at least 6" inside of the plane of the sash and minimize arm movement at the plane of the hood.

5.21 Type III Workplace

Notes:

A Type III workplace is one that provides 2 barriers between the worker and the radioactive material-typically, a glovebox, with the box itself providing the first barrier and the negative ventilation providing the second barrier. Glove boxes are normally vented through one or more HEPA filters. Because high levels of radioactivity can be present in a glove box, it is essential that workers remain vigilant about contamination control

5.22 Type III Workplace

Notes:

Loss of containment can result in:

Significant and widespread area contamination,

Internal dose to workers, and

Extensive programmatic interruption as DOE investigates the cause and determines the consequences.

5.23 Glove Damage

Notes:

Loss of containment occurs most commonly as a result of a breach in the glove box glove, which can result from

Piercing, pinching, or nicking the glove on a sharp object,

Radiolytic damage to the glove from high specific activity material such as Pu-238 or Am-241, or

Damage from a heat source, such as a furnace, hot plate, or a container of high-specific activity material.

5.24 Prevent Glove Damage

Notes:

To help prevent glove damage, you should:

Store sharp tools in a container that prevents incidental contact with hands or gloves.

Tie glove box gloves outside the glove box when not in use.

Use tools whenever force needs to be applied to items or equipment in the glove box.

Use leather gloves when handling items with rough surfaces or wiping a surface that is liable to have splinters or other sharp edges, if practical.

5.25 Preventing Glove Box Glove Damage

Notes:

A breach in a glove box glove may not be visible, and it may not be obvious when a breach occurs. Therefore, it is essential that workers monitor their gloved hands each and every time they are withdrawn from the glove box.

Breaches can also occur at other interfaces, so the worker should periodically monitor for contamination around the glove box access ports, connecting flanges, and on other items in the work area. Monitoring is typically done by taking a large area wipe and monitoring it with a hand-held radiation detector.

5.26 Contamination Control

Notes:

If contamination is detected on PPE other than gloves, or on the external surfaces of the glove box, or on other items in the room ,

it is essential to stop work , touch nothing, and have a co-worker call the ES&H Team.

5.27 Contamination Control

Notes:

Because glove boxes typically contain high levels of contamination, Continuous Air Monitors, or CAMs, are usually required in the work area. If a CAM alarms, everyone must immediately evacuate the room without stopping to conduct exit monitoring. Wait just outside the room and have a co-worker call the ES&H Team, being careful to segregate potentially contaminated people.

Facility-specific orientations will provide additional information regarding response to area alarms.

Click [here](#) to hear about a glove box incident at another DOE facility that resulted in a whole body dose of almost 2,000 mrem.

5.28 Universal Contamination Control Practices

Notes:

Some contamination control practices are universal, whether you work in a Type I, II or III workplace, or a Contamination Area.

The most basic, and most essential practice is 'Good Housekeeping'. Areas that are uncluttered, orderly , and contain only the items necessary for the work are easy to work in, easy to monitor, and easy to decontaminate, if needed. 'Good housekeeping' minimizes the likelihood and extent of cross-contamination, and of missing contamination when monitoring.

Good housekeeping and good contamination control go hand-in-hand, or perhaps I should say, 'hand-in-glove'!

5.29 Monitoring

Notes:

Periodic area monitoring is also essential to contamination control, as it is the only means of detecting an inadvertent spread of contamination.

The ES&H Team conducts and documents routine surveys, which are designed to verify the effectiveness of engineered controls, detect gradual buildup of radioactivity in the workplace, and ensure that area postings are appropriate.

However, these surveys are not designed for contamination control during day-to-day work evolutions. It is an essential worker responsibility to periodically monitor the work area and, if contamination is found outside the designated work place, or contamination levels exceed those allowed in the work control document, to stop work and immediately contact the ES&H Team for assistance.

(Regular Detector in Use) For most radionuclides, monitoring can be done directly using a hand-held radiation detector. For detection of alpha-contamination on items with irregular surfaces

such as a glove box, a large area wipe monitored with the hand-held detector is preferred. (swipe) Some radionuclides, such as tritium and C-14 must be monitored with a smear or swipe, which is subsequently analyzed on a liquid scintillation counter.

If you are unsure of how to monitor your workplace, or which type of radiation detector to use, or how to use it properly, contact the H&S Technician.

5.30 Radiological Barriers and Containments

Notes:

The best radiological programs contain contamination at its source, and contamination that exists outside the containment is kept as low as reasonable achievable within boundaries that are as small as practicable.

Workers are essential to maintaining effective barriers, whether the barrier is a plastic bag, the boundary of a contaminated Type I or II workplace, or the gloves on a glovebox.

Good contamination control techniques for barrier and boundary protection include:

Using only the designated access point to enter and exit the area.

Taping down and marking as potentially contaminated cords and cables that must cross over the contamination boundary, and

Using plastic sleeving or other materials to protect items from cross contamination, where feasible.

5.31 Personal Protective Equipment (PPE)

Notes:

Personal Protective Equipment, or PPE, is used as a secondary means of contamination control.** PPE requirements for working with dispersible radioactive material are specified in the work control document, and almost always include latex gloves and either a buttoned lab coat or coveralls. Shoe covers are required in walk-in Contamination Areas and in some buffer areas, and full Anti-Contamination clothing, or Anti-Cs, are required to work in areas that are highly and extensively contaminated.

You must wear the PPE specified in your work control document and perform self-monitoring of potentially contaminated areas of the body. Be sure to inspect PPE before and during use and replace PPE that becomes contaminated or has tears, holes, or split seams.

5.32 Self-Monitoring

Notes:

Self-monitoring requirements vary depending on the location and type of work being conducted,** as indicated in Document 20.2, Table 3. In general, you want to ensure that you are contamination-free upon completion of your work. **If you are transitioning between an area that has higher levels of PPE controls into an area that has lesser PPE controls, confirmatory monitoring should be done on whatever is worn in the less-controlled area. For example, if upon completion of work in a hood you doff your gloves but keep wearing a labcoat for other work in the area, **then monitor the labcoat and your bare hands upon completion of work in the hood, and before carrying out any

additional work in the lab. If you are removing both the gloves and the labcoat, then monitor your bare hands and your street clothes.

[Click here to learn more about the hazards associated with skin contamination. \(Jump page 16\)](#)

[Click here to learn more about personnel decontamination.](#)

5.33 Module Summary

Notes:

In this module we discussed how to safely conduct work in Type I, Type II and III workplaces. In addition, we covered contamination control practices, including good housekeeping, which are applicable to any work with dispersible radioactive material.

You may review topics covered in this module by selecting a topic from the menu on the left. When done reviewing, select the quiz

button. You must take and pass the quiz for this module before advancing to the next module.

Module 4 Supplemental Slides

5.34 Loss of Containment

Notes:

A few years ago, a worker at another DOE lab received a puncture wound through 4 layers of gloves (cotton gloves, surgeon's gloves, glove box gloves and leather over-gloves) while working in the Pu-239 glove box shown in the picture. The puncture was caused when a very small jagged metal spur generated during the operation penetrated his PPE and entered his thumb, resulting in a contaminated puncture wound. The dose received by the worker was calculated at 1800 mrem to the whole body and 60,000 mrem, or 60 rem, to the bone surface (target organ).

5.35 Skin Contamination Hazards

Notes:

As an industry, we go to great lengths to keep radioactive contamination off workers' skin and personal clothing. This practice ensures that contaminants aren't carried out of the workplace, and that radiation doses to workers are minimized. In some environments, including those with high beta dose rates and 'hot particles', the PPE that keeps contaminants off the skin also prevents dose to the skin. But LLNL doesn't have such environments. Here, tritium is the only radionuclide that can cause a radiation dose via skin contact, and that is a result of absorption through the skin. There was no dose from tritium at LLNL in 2014. Skin contamination with alpha-emitting radionuclides, such as plutonium, does not cause a radiation dose because the alpha radiation cannot penetrate the skin. At LLNL, the primary hazard associated with skin contamination is administrative in nature, as DOE requires us to report skin contamination at very low levels.

5.36 Personnel Decontamination

Notes:

Personnel decontamination is usually a straightforward process, accomplished with soap and water. In rare cases, stronger methods are needed, but these should only be carried out under the direction of Health Services. The basic rule of decontamination is to never abrade the skin by scrubbing or rubbing too hard, as the skin is the barrier between the contaminant and the bloodstream. Personnel decontamination is covered in some detail ES&H Manual Document 20.2, Appendix C. ([Link](#))

Module 5

8.1 Radiological Worker II Training : Contamination Controls

Notes:

This module provides an overview of monitoring and radioactive controls.

8.9 Radiological Monitoring

Notes:

Radiological Monitoring is often associated with control of contamination on surfaces and personnel, but also includes

making dose rate measurements. Radiological workers must conduct operational monitoring of work areas during activities that could affect radiological conditions. They should also monitor before, during, and after completing radiological work.

Radiological workers must promptly notify the ES&H Team of any changes in radiological conditions and of unplanned events.

Normally, the results of radiological monitoring by radiological workers is not required to be documented.

8.10 Radiation Surveys

Notes:

Radiological surveys differ from radiological monitoring in several ways. First, the results of radiological surveys are always documented and records maintained indefinitely. Second, radiological surveys are only performed by persons approved by the RCM to perform radiological surveys such as H&S Techs and ES&H HPs. Finally, radiological surveys are typically performed on a periodic basis based on the radiological hazards of the work area and other needs. The results of

radiological surveys, which are documented as radiological survey records, are available to radiological workers. If you feel you need additional survey information, always contact your H&S Tech. Now let's look at a survey and see how it can help you.

8.11 Contamination Survey Meter Selection / Operation

Notes:

Our standard contamination survey meters detect several kinds of radiation. For alpha emitter contamination, the Ludlum Model 12 with a large area alpha probe is used. Monitor by slowly moving the probe flat and parallel to the surface being surveyed at a distance of $\frac{1}{4}$ inch or less. Response is fairly fast and background for alpha will tend to be very low. For beta/gamma emitter contamination, we use the pancake probe GM meter. The electronics package is normally brown. Response will be fairly fast, but low count rates may be difficult to separate from background (normally less than 50 cpm). Monitor for contamination by slowly moving the probe flat and parallel to the surface being surveyed

at a distance of ½ inch or less. For both types of meters, you can only detect contamination directly under the probe, so if you see increased counts reorient the probe to capture the greatest value before assuming where contamination is present. Proper use of contamination meters requires skill and practice and your H&S Tech can assist you with monitoring techniques and equipment. Let's move on to discuss ways you can control radioactive contamination and ultimately work safely with radioactive material.

8.12 Secure Radioactive Material

Notes:

Your radioactive materials must be properly controlled, in other words you must be confident that you and others will know the disposition of materials. This requires that materials are properly secured and posted or marked. Facilities should be secured at the conclusion of work each day and access controlled using TESA or other lock systems.

8.13 Radioactive Material Control and Labeling

Notes:

Posting and labeling of radioactive materials is a basic part of radiological control. The ES&H Manual Document 20.2, Section 3 contains details on labeling radioactive materials. Radiological labels can be obtained from your ES&H Team. Each item or container of radioactive material, including contaminated items containing radioactive material must have a durable, clearly visible label with the radiation trefoil symbol and the words CAUTION or DANGER Radioactive Material. The label must provide sufficient information to enable persons handling, using, or working around such items to avoid or control exposures.

8.14 Radioactive Material Control and Labeling

Notes:

Whenever practical, include the isotope and activity on radioactive material labels. Labels must remain intact and clearly visible. If an item is too small to be labeled with all of the desired information, the label may be applied to the device or storage

location. If it is impractical to apply a label to the item (e.g., if the surface is rusty, concrete), a painted trefoil or similar marking may be used. If a label is applied to packaged radioactive material, the label must be applied to the outside of the package or be visible through the package. Labels for items with high radiation dose rates may be placed on the shielding container or with another method that minimizes exposure.

8.15 Storing Radioactive Material

Notes:

ES&H Manual Document 20.2, Section 6 contains information on Type 0 Workplaces used for the Storage of Radioactive Material. You must store radioactive material in a posted or labeled cabinet, drawer, or designated area when not in use. Please use a metal or fire-resistant enclosure whenever possible. Ensure radioactive material is sufficiently contained to prevent dispersal. Limit co-mingling of non-radioactive and radioactive materials in storage areas. If a single cabinet needs to be used for both types of material, radioactive material must be segregated on separate shelves or in labeled trays. Do not store radioactive material in or

adjacent to chemicals or flammable liquid storage areas. Outdoor storage of radioactive material is discouraged. In cases where outdoor storage is necessary, the integrity of containers or wrapping materials must be ensured. Shielding or other ALARA precautions may be required for safe storage of radioactive materials. Coordinate with your H&S Tech or Team HP for storing sources that might create whole body doses at or above 5 mrem/h.

8.16 Radioactive Material Movement Inside Same Building

Notes:

The ES&H Manual Document 20.2, Section 7.2 provides details on the movement of radioactive material. Radiological workers are allowed to move radioactive materials (including contaminated items) from one radiologically controlled area to another within the same building. All of the following conditions must be met; The item must be packaged, wrapped, or contained to prevent the spread of contamination. The external packaging cannot have detectable contamination. The item or package must remain in the custody of a radiological worker or be properly labeled (i.e.,

with a 'CAUTION, Radioactive Material' label. Shielding or a transfer device (e.g., a cart, can) must be used when transferring items that exceed 10 mrem/h at contact with the package. The item must be immediately placed in an appropriate radiologically controlled area. Appropriate notification must be provided to the Materials Management Section if transferring; accountable nuclear material, precious metals, Class II, III and IV SRSs, or other controlled items. Coordinate with your H&S Tech to obtain required surveys of materials being transferred either on or offsite.

8.17 Radioactive Contamination

Notes:

One of the hazards of working with radioactive material is the potential for radioactive contamination. You must understand that your actions are vital in preventing and unnecessary or unauthorized spread of radioactive contamination. This reduces the risk and minimizes the costs of working with radioactive material. It is our job as radiological workers to minimize or eliminate unnecessary radioactive contamination. Further, you

should understand that the radioactive contamination limits are not based upon personal safety , but were established based upon instrument detection capability.

8.18 Preventing Contamination

Notes:

The best way to control contamination is to prevent it in the first place. When planning work, determine how you will handle, temporarily store and potentially decontaminate all materials, tools and equipment. Monitor and control contamination caused by ongoing work. Stop work and decontaminate material, equipment and the work area if required.

Inspect and verify the operability of tools and equipment before bringing them into contaminated radiological areas. When clean tools must be used, consider wrapping or placing sleeves on tools or equipment to minimize contamination. Contain or wrap items with accessible surface contamination located outside of contaminated radiological areas to prevent spread of contamination to workers. Radioactive material with sharp edges should be taped or additionally protected to ensure package

integrity. Clear plastic wrapping that is appropriately marked should be used so the bag does not have to be opened for an individual to identify contents. If contamination is detected that is unexpected or exceeds the limits authorized in the work control document; control access to the area and immediately contact the ES&H Team for assistance.

8.19 Contamination Monitoring with Large Area Wipes

Notes:

Contamination found by direct measurement may be fixed or removable. You can determine if the contamination is removable by using large area wipes. To do this, take a clean XXX wipe and fold it to match the size of the detector. Then, using disposable gloves, wipe the XXX wipe over the area being monitored. Hold the wipe close to (but not touching) the detector surface to determine if contamination is present. If removable contamination is present and unexpected, inform your H&S tech immediately and restrict activities to prevent spreading contamination to other surfaces. Properly controlling potentially contaminated material and equipment is an essential part of our

radiological safety program. Failing to do so can have significant impact on our ability to continue to do radiological work. XXX

8.20 Maintaining Contamination Control Continued

Notes:

Excepting walk-in and Type III workplaces, a Contamination Area is simply a higher tier of the basic Type I & Type II radiological work area that is specifically identified and posted or labeled with a Caution Contamination Area sign or label.

When working in Contamination Areas not directly supported by an H&S Tech or RCT, radiological workers must understand the following:

All material and equipment within the Contamination Area are potentially contaminated and must be controlled as such. Any exception to this requirement must be specifically authorized in a work control document.

Monitor workplace to verify general area contamination is less than 100 times Appendix D.

Notify H&S Tech or Team HP if general area contamination exceeds 100 times Appendix D.

8.21 Controlling Contaminated Items

Notes:

Radiological workers may move radioactive material, including contaminated items:

From a posted/labeled Contamination Area to a basic Type I or II work area within the same room if all of the following conditions are met:

Contamination from the item is not likely to result in an un-posted Contamination Area.

Movement of the item is done in a manner that prevents the spread of contamination during transfer.

The potentially contaminated status of the item is retained (e.g. label the item as potentially contaminated or place in an equivalently labeled area or container).

From a posted/labeled Contamination Area to general work areas within the same room (posted as a Radioactive Material Area) if the item is contained and labeled to indicate appropriate radiological status.

Your role in this area is to ensure that any material and equipment that is potentially contaminated is never released improperly. We should review what you are allowed to do in this regard.

8.22 Release of Material and Equipment

Notes:

The most important thing for you to remember about releasing material and equipment is that only an individual fully qualified as a radiological control technician may release items that are potentially contaminated or potentially activated. Potentially contaminated includes any material that was inside a posted contamination area, high contamination area, or airborne radioactivity area. It also includes any equipment or material that came in contact with dispersible contamination or in contact with any potentially contaminated item or surface. This also includes any item or equipment that you monitored and found contaminated - even if you decontaminated it.

8.23 Release of Material and Equipment continued

Notes:

An individual is authorized to remove and release items that have not been associated with Type I, II or III work areas and are not suspected of being contaminated. No survey or monitoring is

required to perform this action. A radiological worker may also remove and release items from areas associated with Type I or II work areas provided that the item is not labeled indicating the presence of radioactive material or not suspected of being contaminated. Release of these items requires monitoring by the radiological worker with an appropriate instrument. If you have any doubt regarding the potentially contaminated status of an item, you must contact your H&S Tech for assistance prior to allowing the item to be removed from any area demarcated, labeled or posted for radiological purposes. This means that you must use good judgment if you intend to remove an item from any area where radioactive material is used or stored.

8.24 Controlling Contaminated Items

Notes:

Tools should be maintained in a designated storage or distribution area or a contaminated tool crib. Monitor potentially contaminated material to separate uncontaminated from

contaminated materials. Segregate known uncontaminated from potentially contaminated waste. Segregate reusable items, such as protective clothing, respirators, and tools, at the barrier of the contamination area. Minimize the number and size of radioactive material areas. Materials suspected of being mixed waste (both radioactive and hazardous) must be identified and segregated as soon as practical to avoid combining mixed waste with other waste forms.

8.25 Control of Radioactive Waste

Notes:

Collection and disposal of radioactive and mixed wastes is the responsibility of the Radioactive and Hazardous Waste Management Program or RHWL but you have to do your part. You have to use waste minimization techniques and segregate contaminated materials from non-contaminated items. Contact your RHWL technician for assistance.

8.26 Personnel Contamination Monitoring

Notes:

Personnel contamination control is dependent on proper monitoring. Various types of monitoring equipment are used to find contamination so it can be properly controlled before personnel leave potentially contaminated areas. Personnel contamination monitors come in two types; fixed contamination monitors and portable contamination survey meters. In general, fixed monitors have the advantage in that they are more sensitive and usually have built-in alarms to indicate when contamination is found. A drawback is that these units can be quite large and there may not be enough space to install them in all locations. These units are also comparatively expensive. Fixed monitors are not as widely available as portable survey meters. Fixed personnel monitors come in many configurations.

8.27 Fixed Monitors

Notes:

Your H&S Tech can assist you with the use of fixed monitors in your facility. Some models use a single alpha detector attached to the front of a glove box, others have multiple detectors of various types with preset alarm levels. These are sometimes referred to as hand and shoe or portal monitors. If such a monitor alarms during use, or if activity is detected on a hand-held detector, contamination may have been detected. The alarm could be false but must be investigated in all such situations. In most facilities, you may repeat the measurement twice and if the detector does not alarm or contamination is not detected on the subsequent measurements, you may assume the initial indicator was false and you may leave the area. If the detector alarms or contamination is detected on either of the follow-up measurements, you must call the H&S Tech and wait in the immediate area until assistance arrives. In all cases, while the event is being reviewed, prevent others from walking through potentially contaminated areas until the H&S Tech arrives and takes control of the area.

8.28 Personnel Monitor Types

Notes:

Most of the time you will be using portable contamination survey meters. To monitor or “frisk” with portable survey meters, first perform the operational checks on the meter. Then hold the probe less than 1/2 inch from the body surface being monitored for beta and gamma contamination and approximately 1/4 inch for alpha contamination. Move the probe slowly over the body surfaces at approximately 2 inches per second. If the count rate increases during frisking, pause for 5 to 10 seconds over the area to provide adequate time for the instrument to respond. If the count rate increases to more than three times background or if the instrument alarms, remain in the area and notify radiological control personnel. Monitoring the whole body should take about three minutes.

8.29 Contacting ES&H Team

Notes:

You are responsible for keeping your H&S Tech or Team HP informed of the status of work activities that affect radiological conditions. Changes in materials, activities used or processes are

obvious, but you must also notify the ES&H Team of any changes in the workplace that might increase a worker's dose or affect radiological postings. Upon identification of radiological concerns (e.g., inappropriate work controls or procedural deficiencies), you must immediately report the concern to the Responsible Individual and the ES&H Team. Finally, if needed to control exposure to radiological hazards, workers may need to exit the radiological area until issues are resolved and appropriate controls are in place. If you are in doubt about contacting the ES&H Team, just go ahead and DO IT ANYWAY.

8.30 Module Summary

Notes:

In This module we have discussed contamination and radioactive material controls

You may choose to review any topics you feel unsure about at this time by using the menu on the left to select a topic. When you are finished reviewing, select the topic on the menu and click on

the quiz button. You may also wish to refer to the glossary if you have any questions about the terms used in the module. When you are ready, click the quiz button to take the quiz.

Module 6

6.1 Radiological Worker II Training : Contamination Controls

Notes:

This module concludes our discussion of how to safely conduct work with dispersible materials at the Lab.

Let's start by discussing PPE usage in contaminated areas.

6.5 Leaving a Radiologically Controlled Area

Notes:

When exiting a radiological materials area you must verify that you are not transporting any contamination in to a clean area. This is done by monitoring your hands, arms, feet and upper torso

as prescribed on the posting or on your working authorizing document.

6.6 PPE Safe Removal

Notes:

Radiological PPE required for work must be properly removed when leaving a contaminated radiological area. Potentially contaminated protective clothing must be removed without spreading contamination and without contaminating the skin. Do not touch your face or mouth during protective clothing removal. The ES&H Manual Document 20.2, Section 6.4.5 provides details on removing complete sets of PPE. The basic process for removing standard PPE is as follows:

1. Monitor your disposable gloves before touching anything, including the survey probe.
 2. If your gloves are contaminated, slowly and carefully remove your gloves, rolling them inside out and disposing of them properly in the radioactive waste.
 3. Remove your remaining PPE touching only inner surface that are not likely contaminated.
 4. Monitor your whole body using a hand held survey meter or personnel contamination monitor as appropriate.
 5. If you do find contamination on yourself, immediately stop the process and have someone else call your H&S Tech to respond and assist you in with decontamination procedures.
- Only leave when you are confident that no contamination is

present that could be spread from the facility. So what about removing a set of full anti-contamination PPE?

6.7 Anti-Contamination PPE Removal

Notes:

For removing a full set of anti-contamination PPE, we need to add some steps to the basic process. First, it is much easier to self-monitor if you have a partner monitor your back after you remove your coveralls. Usually a H&S Tech will be present to assist you in leaving a known contaminated area.

- Remove outer pair of gloves.
- Remove hood or other head cover starting at the front of the head and moving to the back of the head.
- Remove coveralls, turning them inside out, touching the inside only.
- Remove any respiratory protection, if used.
- Remove each shoe cover, placing over hot zone threshold shoe and onto the clean step-off pad.

- Remove inner gloves.
- Perform careful whole-body frisk.
- Monitor ID badge and dosimeters.

When leaving a contaminated area, sometimes called a “HOT ZONE,” observe all contamination control procedures, using step-off pads and carefully monitoring yourself, tools and equipment being brought into a “CLEAN” area. Failure to control contamination properly may result in contamination being spread unknowingly throughout a facility. Now let's talk about what to do if you find yourself to be contaminated.

6.8 Contacting ES&H

Notes:

The first thing to do is to remain calm and if you have others with you, warn them. You should minimize your movements to avoid spreading contamination and should remain as close as you can to the monitoring station. At the same time, you must contact the ES&H Tech or ES&H Team and request assistance. ES&H Team members are trained to respond to

these types of events and will respond promptly to help you. Let them know what happened and where you were working when they arrive and follow their direction with regards to getting any contaminated clothing removed safely. If skin decontamination is required, the ES&H Team will help you. After the contamination has been removed, you should immediately notify your work supervisor and facility management of the event. There will likely be a critique of management meeting about how you became contaminated. Be an active participant in the investigation because all of us need to know what happened and work to prevent similar events in the future.

6.9 Module 6 Summary

Notes:

This module has discussed how to safely exit radiological areas by:

- Removing your PPE safely and in the proper sequence
- Limiting contamination found during monitoring
- Contacting the ES&H Team for assistance AND
- Preventing the spread of contamination

Notes:

You may choose to review any topics you feel unsure about at this time by using the menu on the left to select a topic. When you are finished reviewing, select the topic on the menu and click on the quiz button.

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Module 6 Supplemental Slide

6.11 Preventing Spread of Contamination

Notes:

Improperly exiting a contaminated area can quickly cause major problems. An event at a major university in the mid 1990s gives us an example of what can happen. A radioisotope researcher did not properly monitor his PPE before leaving work at the end of the day. The next day, a second researcher notified the responsible health physicist that the lab's survey meter was showing a high background. Upon arrival at the 3rd floor lab, the health physicist found that the survey meter

probe was contaminated as well as a telephone, a radio dial, the lab doorknob and the lab floor. Further investigation found contamination in the 3rd floor bathroom, in the elevator, on the hallway floors and in the NEW car of the researcher. Required decontamination was expensive and time consuming and it was more than 2 weeks before the lab was returned to work status. Luckily, radiation doses were minimal even though 5 persons were contaminated as a result of the incident. The researcher later told the health physicist that he was using the survey meter but didn't remember monitoring his PPE before he left the lab. Proper monitoring would have made all the difference. So, when you are exiting a contaminated radiological area, take your time and do it right. A few extra minutes can keep you safe and avoid costly recovery actions.

Module 7

7.1 Radiological Worker II Training : Contamination Controls

Notes:

This module discusses off-normal and emergency situations and the appropriate responses.

Let's start by discussing how a normal condition differs from an off-normal condition.

7.5 Normal Conditions

Notes:

Normal conditions exist when the contamination or radiation levels for the given work situation are as you expected and the authorizing work document's identified hazards and controls are consistent with the actual radiological conditions. This means the work controls are adequate since the radiological conditions match those-expected during planning activities. These operations demonstrate proper planning and execution and ensure radiation doses are ALARA and the spread of contamination is controlled. So what exactly is an off-normal condition?

7.6 Off Normal Conditions

Notes:

Off-normal radiological conditions are conditions created when the actual radiological conditions fall outside of the approved work controls. This could be because the scope of activities that

you are performing have changed and the work document authorizing the activity hasn't been updated. There could also be other-indicators of potential off-normal radiological conditions. Sometimes, it's a subtle thing. You know, something just doesn't look right. If you notice something that looks wrong, you need to investigate and take appropriate actions. To be vigilant to such subtle things, you need to maintain an ongoing awareness of the radiological and other conditions in the work area. On the other hand, some conditions are more obvious. Some examples include:

- You see a container has turned over, resulting in a radioactive material spill

- You find unexpected radiation readings or contamination levels

- You hear a continuous air monitor or CAM alarm

Regardless of the off-normal condition, you are expected to take the actions necessary to minimize your potential exposure and that of your co-workers and to notify the ES&H Team and your supervisor so that the off-normal condition can be addressed. So what types of off-normal conditions could develop?

7.7 Types of Off Normal Conditions

Notes:

Off-normal conditions are always of concern, however one that could be elevated to the status of an emergency is one that involves injuries in a radiological area. There may also be situations that require you to immediately exit from an area controlled for radiological purpose. A good example would be an accidental breach of a radioactive system that release liquids or airborne radioactivity. Spills of radioactive material are also considered off-normal conditions. Let's start by discussing the potentially most significant one; that is one involving injuries in a radiological area

7.8 Medical Response

Notes:

First, caring for the medical injury almost always takes precedence over radiological considerations. About the only exception would be a situation where very high whole body dose rates (>100 Rem/hr) are present. In that extremely rare radiological

environment, it may be necessary to move away from the radiological source term before rendering care due to the potential for radiological harm but in all other cases, care of medical injuries always takes precedence over contamination control and other radiological measures. First, call 911 and report the injury and the radiological conditions. Provide emergency medical support to the injured personnel until help arrives. If there are no injuries, or apparently only minor injuries, workers must:

- Warn others in the immediate area and place work in a safe configuration, then, stop work.
- Take reasonable steps to keep the situation from becoming worse but only if it is safe to do so.
- Leave the area and close the doors, then secure the area and prevent unauthorized entry.
- Immediately notify the ES&H Team. This is essential, particularly in cases of apparently 'minor' injuries, which may have potentially significant internal dose consequences.
- Notify the authorizing individual of the event.

7.9 Injury Reporting

Notes:

If you are injured in a radiological area, there may be additional concerns about the injury or event. Since punctures in the skin are one of the routes of entry for contamination to enter the body it is important that you report skin punctures and other skin wounds that occur in any radioactive material area or radiological area to your supervisor and the ES&H Team as soon as you are aware of them. The ES&H Team and LNLL internal dosimetrists will work with the medical staff to ensure that your wound is decontaminated and any appropriate dose reduction techniques utilized to minimize your internal radiation dose due to the event.

7.10 CAM Alarm Response

Notes:

Another unusual condition is one involving airborne radioactivity. We discuss actions to take to an airborne radioactivity situation next.

Continuous Air Monitors or CAMs are real-time air sampling devices that contain a radiological detector system. CAMs monitor ambient air for increases in radiological aerosols or vapors. CAMs are normally preset to alarm with an audio and visual indicator when an increase in airborne radioactivity is detected. Should a CAM alarm while you are in the area, and you are not wearing a respirator, the appropriate response is to:

- Immediately leave the room or area, closing doors behind you
AND
- Remain near the area, contact your H&S Tech immediately to report the CAM alarm and wait for them to respond and release you from the area.

If you are wearing a respirator, place work in a safe configuration and then leave the room, unless otherwise specified in a work control document. Once you are out of the affected area, remember to report all ALARMS to your H&S Tech and your supervisor, immediately. NOTE: You are not allowed to disregard

any radiological alarm - never assume any alarm is a false alarm - always evacuate when you hear a CAM alarm. Sometimes, it is not an alarm but another unusual condition like a spill.

7.11 Radioactive Material Spill Response

Notes:

If a spill occurs, use the acronym SWIMS:

- Stop the operation causing the spill, if it can be done safely
- Warn others in the area and notify the H&S Tech immediately
- Isolate the spill area, if possible
- Minimize individual exposure and contamination
- Secure unfiltered ventilation (fan, open windows, etc.) if you are qualified to do so

Restoring the contaminated area to normal is the responsibility of the authorizing organization. The ES&H Team will provide radiological monitoring and over-all safety guidance and assistance.

7.12 Decontamination

Notes:

Contamination of skin and personal clothing sometimes results from work with radioactive materials as well as from off-normal conditions. If skin or personal clothing contamination is detected, immediately contact the ES&H Team for assistance. XXX

7.13 Module 7 Summary

Notes:

This module had covered off-normal and emergency situations and appropriate responses.

You may choose to review any topics you feel unsure about at this time by using the menu on the left to select a topic.

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